

## CLAIMS

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

- 5     1.     A mold apparatus for molding a component onto a stretched blank comprising:  
a first mold part;  
a second mold part;  
a stretching assembly disposed between said first mold part and said second mold  
part, said stretching assembly including a plurality of clamp assemblies operable to grip the  
10 periphery of the blank and hold the blank, said stretching assembly further including a  
plurality of slide assemblies for selectively moving said clamp assemblies to apply a stretch  
to the blank; and  
an apparatus for closing said first mold part and said second mold part on the blank  
while the blank is held in a stretched condition by said stretching assembly.

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2.     The apparatus of claim 1, wherein said stretching assembly includes a plate defining a  
central opening permitting said first mold part and said second mold part to close on the  
stretched fabric, said slide assemblies being movably mounted to said plate and said clamp  
assemblies operatively mounted to said slide assemblies.

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3.     The apparatus of claim 2, wherein at least one of said plate and said first mold part is  
movable between a first position in which said central opening is unpenetrated by said first  
mold part and a second position in which at least a portion of said first mold part extend  
through said central opening.

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4.     The apparatus of claim 2, wherein said plate is movably mounted to said first mold  
part and is movable between a stretch position and a mold position.

5.     The apparatus of claim 4, further including biasing means for biasing said plate in  
30 said stretch position.

6. The apparatus of claim 5, wherein said biasing means is further defined a plurality of springs disposed between said plate and said first mold part.

7. The apparatus of claim 6, wherein said mold moving apparatus is operable to move  
5 said second mold part toward and away from said first mold part, said plate movably disposed between second mold part and said first mold part, wherein movement of said second mold part moves said plate between said stretch position and said mold position.

8. The apparatus of claim 7, wherein said second mold part includes at least one ram,  
10 said ram extending from said second mold part to engage said plate as said second mold part is moved toward said first mold part.

9. The apparatus of claim 6, wherein at least one of said slide assemblies includes a slide  
15 movably mounted to said plate and a stretch cylinder interconnected between said slide and said plate, whereby extension and retraction of said stretch cylinder results in movement of said slide with respect to said plate.

10. The apparatus of claim 9, wherein at least one of said clamp assemblies includes a  
20 clamp head pivotally mounted to one of said slides and a clamp cylinder interconnected between said clamp head and said slide, wherein extension and retraction of said clamp cylinder results in pivotal movement of said clamp head with respect to said slide.

11. The apparatus of claim 10, wherein said stretching assembly includes a plurality of fabric pins; and

25 further including a robot for transferring the blank from a loading station to the stretching assembly, said robot including a placing tool including a plurality of shot pins arranged to align with said fabric pins when said placing tool is positioned adjacent to said stretching assembly.

12. The apparatus of claim 11, wherein at least one of said shot pins includes a transfer pin and a sleeve, at least one of said transfer pin and said sleeve being movable with respect to said other of said transfer pin and said sleeve, wherein actuation of said shot pin pushes the blank off of said transfer pin and onto a corresponding one of said fabric pins.

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13. The apparatus of claim 11, further including an air knife assembly mounted to said robot arm adjacent to said placing tool.

14. The apparatus of claim 13, further including a stretch measuring assembly mounted to  
10 said robot arm adjacent to said placing tool.

15. The apparatus of claim 14, wherein said stretch measuring assembly includes a frame, a plurality of blocks movable mounted to said frame, a plurality of fabric needles mounted to said blocks and a sensor for generating signals indicative of movement of said blocks with  
15 respect to said frame.

16. A stretching assembly for use with a molding apparatus to mold a component onto a stretched blank comprising:

a support structure mounted adjacent to at least one mold part;

20 a plurality of slide assemblies mounted to said support structure, each of said slide assemblies being movably mounted to said support structure for reciprocal motion; and

a plurality of clamp assemblies, at least one clamp assembly mounted to each of said slide assemblies, said clamp assemblies being movable between an open position and a closed position.

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17. The assembly of claim 16, wherein said support structure includes a plate, said plate defining a central opening adapted to be fitted over at least one mold part.

18. The assembly of claim 17, further including means for moving said plate with respect to the at least one mold part between a stretch position in which said central opening is unpenetrated by the at least one mold part and a mold position in which said central opening is penetrated by at least a portion of the at least one mold part.

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19. The assembly of claim 18, further including a spring means for biasing said plate away from the at least one mold part.

10 20. The assembly of claim 19, wherein at least one of said slide assemblies includes a slide movably mounted to said plate and a stretch cylinder interconnected between said slide and said plate, wherein extension and retraction of said stretch cylinder results in movement of said slide with respect to said plate.

15 21. The apparatus of claim 19, wherein at least one of said clamp assemblies includes a clamp head pivotally mounted to one of said slides and a clamp cylinder interconnected between said clamp head and said slide, wherein extension and retraction of said clamp cylinder results in pivotal movement of said clamp head with respect to said slide.

20 22. The apparatus of claim 20, wherein a strain gauge is disposed between said stretch cylinder and at least one of said plate and said slide to generate signals indicative of a force being applied to the blank.

25 23. The apparatus of claim 19, wherein said plate defines a plurality of guide holes, said guide holes adapted to be fitted over alignment rods in the at least one mold part to movably support said plate adjacent to the at least one mold part.

24. A tooling assembly for use on the end of a robot arm comprising:

a frame capable of being mounted to a robot arm; and

a placing tool for placing a blank in a desired location, said placing tool including a plurality of shot pins mounted to said frame, each of said shot pins including a transfer pin  
5 and a sleeve, said transfer pins adapted to receive the blank, at least one of said sleeve and said transfer pin being selectively movable with respect to the other of said sleeve and said transfer pin, wherein such movement pushes the blank off of said transfer pin.

25. The tooling of claim 24, wherein each of said transfer pins is selectively retractable  
10 within said sleeve.

26. The tooling of claim 25, wherein said shot pins are pneumatically actuated, wherein a partial vacuum is applied to said shot pins to retract said transfer pins.

15 27. The tooling of claim 24, further comprising an air knife assembly mounted to said frame.

28. The tooling of claim 27, wherein said air knife assembly includes a first nozzle array for expelling pressurized air in a first direction and a second nozzle array for expelling  
20 pressurized air in a second direction.

29. The tooling of claim 24, further comprising a stretch measuring assembly mounted to said frame.

25 30. The tooling of claim 29, wherein said stretch measuring assembly includes a frame, a plurality of blocks movable mounted to said frame, a plurality of fabric needles mounted to said blocks and a sensor for generating signals indicative of movement of said blocks with respect to said frame.

31. The tooling of claim 24, further comprising a picking tool for grasping a part to be removed from a mold, said picking tool mounted to said frame on a side opposite the shot pins.

32. A method for molding a component onto a loaded blank, comprising the steps of:

5 installing a blank onto a stretching assembly;

stretching the blank by operation of the stretching assembly;

closing first and second mold parts onto the blank while the blank is held in a stretched condition by the stretching assembly;

10 molding a component onto the blank while the blank is held in a stretched condition by the stretching assembly; and

removing the blank with the molded component from the mold.

33. The method of claim 32, further comprising the step of moving the stretching assembly into a stretch position prior to said installing step wherein the fabric is not in  
15 contact with the mold.

34. The method of claim 33, further comprising the step of moving the stretching assembly into a mold position after said stretching step wherein the fabric is in contact with the mold.  
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35. The method of claim 34, further comprising the steps of:

loading the blank onto a placing tool mounted to a robot arm;

operating the robot arm to move the placing tool into a position adjacent the stretching assembly; and

25 transferring the blank from the placing tool to the stretching assembly.

36. The method of claim 35, wherein said transferring step includes the steps of operating one or more shot pins mounted to the placing tool to push the blank off of the placing tool and onto one or more fabric pins mounted to the stretching assembly.

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37. The method of claim 34, wherein said stretching step includes the steps of:  
closing at least two clamps onto the blank to hold the blank in the stretching  
assembly; and

operating the stretch assembly to create relative movement between the at least two  
5 clamps, wherein the relative movement applies a stretch to the blank.

38. The method of claim 34, wherein said stretching step includes the steps of:

closing a first pair of clamps onto the blank;

operating the stretch assembly to create relative movement between the first pair of  
10 clamps to apply a first stretch to the blank;

closing a second pair of clamps onto the blank;

operating the stretch assembly to create relative movement between the second pair of  
clamps to apply a second stretch to the blank.

15 39. The method of claim 34, further comprising the step of:

opening the mold while the blank remains secured to one of the mold parts to move  
the blank and molded component away from the other of the mold parts.

40. The method of claim 39, wherein said step of moving the stretching assembly into a  
20 mold position is further defined as moving a first mold part toward a second mold part  
along a path, wherein the stretch assembly is disposed in the path such that the first mold part  
engages and moves the stretch assembly into the mold position.

41. The method of claim 40, wherein the stretching assembly is biased in the stretch  
25 position, whereby the stretching assembly moves from the mold position into the stretch  
position by the bias as the first mold part is moved away from the second mold part.

42. The method of claim 37, wherein said stretching step further includes the step of  
expelling pressurized air against at least a portion of the blank to straighten the blank for  
30 clamping.

43. A molding apparatus comprising:

a mold having a first mold part and a second mold part, at least one of said mold parts being movable along a path to close on the other of said mold parts;

5 a stretching assembly for stretching a blank and holding the blank in a stretched condition, said stretching assembly disposed along said path, wherein a stretched blank held by said stretching machine may be enclosed between said mold parts when said mold parts are in a closed position.

44. A fabric stretch measuring assembly comprising:

10 a frame;

a plurality of fabric needles mounted to said frame to be selectively engaged with a fabric, a first one of said needles being movably mounted to said frame, wherein said first needle is movable with respect to a second one of said needles as an engaged fabric stretches and relaxes; and

15 means for measuring movement of said first needle.

45. The assembly of claim 44, wherein said means for measuring includes a linear transducer.

20 46. The assembly of claim 44, further including a needle guard movable between a closed position covering at least one of said fabric needles and an open position exposing said fabric needle.

25 47. The assembly of claim 44, further including a block movably mounted to said frame, said first needle being mounted to said block.

48. The assembly of claim 44, further including a first block and a second block, each of said blocks being movably mounted to said frame, said first needle being mounted to said first block, said second needle being mounted to said second block.

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49. The assembly of claim 44, further including a base and a cylinder, said cylinder interconnecting said base and said frame, whereby extension and retraction of said cylinder results in movement of said frame with respect to said base.

5 50. The assembly of claim 46, further including a base and a cylinder, said cylinder interconnecting said base and said frame, whereby extension and retraction of said cylinder results in movement of said frame with respect to said base; and

wherein said needle guard is pivotally mounted to said base such that movement of said frame with respect to said base results in movement of said needle guard between said  
10 open position and said closed position.

51. The assembly of claim 48, further including a third block and a fourth block, each of said blocks being movably mounted to said frame, a third needle being mounted to said third block, said fourth needle being mounted to said fourth block.

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52. The assembly of claim 51, further including at least one alignment rod extending between said frame and said base to address rotation of said frame with respect to said base.